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Energy production, consumption, policies, and recent developments in Turkey

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Abstract

Turkey is geographically in the middle of the world, which means it is surrounded by the Middle East, Central Asia and Europe. This area is not only geographically, but also economically, very important. Turkey has a very young and increasing population. In addition to the increase in population, a growing number of city dwellers and rapid economic development are causing more energy consumption. In the last 20 years, Turkey has become a considerably sized, growing energy market in the world. The domestic share of total energy consumption is 37%, and between the years 2000 and 2010, the cost for needed energy will be approximately 55 billion US$. The government has been planning for 81% of this amount as an investment. Considering the country's economic conditions, Turkey must come up the plan which reduces the share of fossil fuels, increases energy production (including use of more alternative energy sources), and changes the coarse of long-term energy plans into very effective and applicable solutions. In this study, energy reserves, energy demand, energy production, energy consumption, energy policies, and recent developments are investigated and evaluated.

Keywords: Energy reserves; Energy demand; Energy production; Energy consumption; Energy policies

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1. Introduction

Because of its geopolitical position, Turkey can be considered as a bridge for energy to connect Europe to Asia and the Middle East. After the breakup of the Soviet Union and the end of the Gulf War, Turkey is playing an even more important role. Turkey has improved its economic situation in recent years, and this has caused more energy needs, which means more consumption and more imports.

The port of Ceyhan is the most important outlet for Iraqi oil exports and for potential future Caspian oil. The population of Turkey is 70 million. The economic growth rate is the 16th largest in the world. The energy needs of the country are also increasing gradually. For example, the gas demand of Turkey from the 1990s has been increasing 10% per year, and by 2005, these demands are expected to four times more, which means 45 billion m^3. It is expected that 22 million tons will have been imported by 2010 in order to meet oil needs.

Turkey's most important goal of the future is energy. The increase in the demand rate for energy is 8% per year. It requires installing 3500 MW of energy generation capacity systems per year, and private and public financial sources must be evaluated to meet this demand.

Turkey's electric energy needs have been increasing at a rate of 11% per year for the last four decades, and the Turkish government is planning for an 8% growth rate annually for the next 15 years. By the year 2010, the electric energy consumption will have reached 240 billion kWh. Considering this, the government is also planning to install 33 lignite, 27 natural gas, 12 coal, two nuclear, and 113 hydroelectric energy plants to fulfill this need.

2. Turkey's energy sources

The main energy resources of Turkey are hard coal, lignite, asphaltite, petroleum, natural gas, hydroelectric energy, and geothermal energy.

Turkey's natural energy resources are quite miscellaneous, for example, hard coal, lignite, asphaltite, oil, natural gas, hydro, geothermal, wood, animal and plant wastes, solar and secondary energy resources, coke, and briquettes. These resources are produced and consumed in the country. Turkey does not own large fossil fuel reserves. In the future, it seems that it will be very difficult to meet the anticipated demand for oil, natural gas, and even coal. On the other hand, Turkey has huge reserves of renewable energy sources.

2.1. Renewable energy sources

Turkey's renewable energy sources are plentiful and extensive. Renewable energy production makes up approximately 14.4% of the total primary energy supply (TPES), i.e. 10.10 million tons of oil equivalent (Mtoe) in 1999, and renewable sources represent the second-largest domestic energy source after coal. Primary renewable energy resources in Turkey are: hydro, biomass, wind, biogas, geothermal, and solar.

Turkey's renewable energy potential is given in Table 1 [1].

Considering recent studies, the usable hydropower potential of Turkey is estimated at 125,000 GWh/year (34,729 MW), as given in Table 1. 24,010 GWh of this potential was produced in operating hydropower plants (HPPs) in 2001 [2].

2.2. Fossil energy sources

Turkey's main energy resource is coal, which has been produced for years domestically, and its share of the country's total energy consumption is about 24%. It is used mainly for power generation, cement production, and steel manufacturing [3]. Turkey is one of the biggest producers of lignite in the world. This comes predominantly from deposits of the Southwest and the Southeastern Afsin-Elbistan Basin, where 7339 million tons lignite is economically usable. The biggest lignite deposits (40% of the total) are in Elbistan [3]. The

Table 1
Turkey's renewable energy potential

Energy type		Usage purpose	Natural capacity	Technical	Economical
Solar energy		Electric (billion kWh)	977.000	6.105	305
		Thermal (mtoe)	80.000	500	25
Hydro power		Electric (billion kWh)	430	215	124.5
Wind	Direct energy (land)	Electric (billion kWh)	400	110	50
	Direct energy (off shore)	Electric (billion kWh)	—	180	—
	Wave energy	(billion kWh)	150	18	—
Geothermal energy		Electric (10^9 kWh)	—	—	1.4
		Thermal (mtoe)	31.500	7.500	2.843
Biomass energy		Total (mtoe)	120	50	32

Table 2
Fossil energy sources in Turkey [3]

Sources	Apparent	Probable	Possible	Total
Hard coal (million tons)	428	449	249	1126
Lignite (million tons)	7339	626	110	8075
Asphaltite (million tons)	45	29	8	82
Bituminous schist (million tons)	555	1086	269	1641
Oil (million tons)	36	—	—	36
Natural gas (billion m^3)	8,8	—	—	8

government plans to increase the coal supply from 20.1 Mtoe in 1999 to 118.4 Mtoe in 2020. It is believed that domestic lignite production will be almost tripled.

The amount of fossil energy resources in Turkey is shown in Table 2.

3. Energy consumption and production

3.1. Oil

The use of oil has been increasing gradually for the last several decades. Especially keeping with the pace of globalization and the rapid industrial development of the world, this result is inevitable in Turkey. Approximately, 42% of Turkey's total energy needs have been fulfilled by oil. Because of natural gas, this rate has started to decrease. Roughly 90% of Turkey's oil supplies are imported. This importation chiefly comes from the Middle East, Saudi Arabia, Iran, Iraq, Syria, and Russia. Turkey's port of Ceyhan is a major outlet for Iraqi oil exports, with a pipeline capacity from Iraq of about 1.2 million bbl/d [4].

Turkey's oil production is provided mainly by three companies: the Turkish State Petroleum Company (TPAO) and two foreign operators-Royal Dutch/Shell (Shell) and Exxon Mobil. In addition to these companies, there are other small companies such as Petrom of Romania, which produces around 2600 bbl/d in the Selmo block, and Aladdin Middle East, producing about 480 bbl/d in Siirt and Gaziantep.

TPAO by itself provides about 80% of the Turkey's total oil output, which is currently around 56,000 bbl/d, down from 90,000 bbl/d in 1991. In general, Turkey has small oil areas. These are located in different parts of the country. In the southeast area called Hakkari Basin is Turkey's chief oil-producing area. The oil in other areas is very difficult to find and produce. Apart from the Hakkari Basin, Turkey provides oil from the Black Sea shelf region, and from other oil basins in southern and southeastern regions of the country [5].

Since September 1994, TPAO has been part of the Azerbaijan International Operating Company (AIOC), a corporation of foreign oil companies in a multi-billion$ oil production-sharing pact with Azeri State Oil Company, SOCAR, to improve three offshore oil fields in the Caspian Sea region. TPAO comprises 6.75% of AIOC. TPAO has also been working with the other part of the world's oil companies, such as those in the Middle East, North Africa, and Kazakhstan.

3.2. Natural gas

In 2000, Turkey consumed 520 billion cubic feet (Bcf) of natural gas. Nearly this entire amount was imported and was approximately 17% of Turkey's total energy consumption for the year. In 2002, the amount of the natural gas consumed reached around 700 Bcf. Owing to severe economic problems in the last few decades, in addition to fluctuating prices before Turkey's recent severe economic matters, the Turkish natural gas was anticipated to increase excessively rapidly over the next years, with the most important consumers anticipated to be natural-gas-fired electric power plants and industrial users [6].

Natural gas is Turkey's chosen fuel for new power plant capacity development due to several requirements. These are firstly for environmental reasons because gas is less polluting than coal, lignite, or oil; secondly, for geographic reasons because Turkey is close to very large amounts of gas in the Middle East and Central Asia; and thirdly, for

economic reasons because Turkey could balance part of its energy import bill through transit fees it could charge for oil and gas shipments across its territory and seas; and lastly, for political reasons because Turkey is looking to develop strong relations with Caspian and Central Asian countries, some of which are naturally very big gas exporters.

Turkish natural gas production was 23 Bcf in 2000. This met around 4% of domestic natural gas consumption needs. Main natural gas producers in Turkey are Arco, TPAO, and Shell. Marmara Kuzey (known as North Marmara in English), which founded in May 1997, is the country's largest non-associated gas field. Marmara Kuzey is placed offshore in the Thrace-Gallipoli Basin of Marmara Sea.

Production capacity is estimated to be as high as 100 Bcf/year. In addition to this, in July 2001, TPAO declared that it had found gas in Turkish areas of the Mersin and Iskenderun Baysamong tons (Mmst) of coal, mainly lignite. Between 1990 and 2000, the number of workers in Turkey's coal sector fell from 63,993 to 35,665. Turkish coal is generally of lower than average quality. It is used mainly for power generation [6].

3.3. Electric power

TEAS, Projections by Turkey's Electricity Generating and Transmission Corporation, is a public company that owns and operates 15 thermal and 30 hydroelectric plants. TEAS is generating 91% of Turkey's electricity. It has been announced that due to the rapid growth in electricity consumption, as high as 9–10% per year, this will continue over the next 15 years. Because of generation and distribution losses as high as 30%, and partly as a result of under investment, electricity shortages, brownouts (periods of reduced voltage of electricity caused especially by high demand and resulting in subnormal illumination), and blackouts (periods of darkness (as in a city) caused by a failure of electrical power), already commonly increasing electricity generation capacity therefore is a top priority for Turkish energy officials. According to the Ministry of Energy and Natural Resources (MENR), meeting Turkey's power needs could require investments of $4–$4.5 billion/year, much of which would need to come from the private sector. Turkey has plans for an additional 23,603 megawatts (MW) in power generating capacity by 2020, nearly double the country's 26,226 MW present capacity [7].

Turkey passed the long-expected Electricity Market Law in February 2001, which the President signed into law in July 2001. This paves the way for a free market in power generation and distribution. The legislation mainly calls for:

1. TEAS to be broken up into separate generation, distribution, and trade companies;
2. trade and generation companies to be privatized, while transmission remains in state hands; and
3. a new regulatory board to be set up that will oversee the Turkish power market, set tariffs, issue licenses, and prevent uncompetitive practices.

The new law throws into doubt the fate of dozens of BOT and Transfer-of-Operating-Rights (TOR) power projects. The Energy Ministry put six power plants and nine distribution grids for sale in May 2002.

In southern Turkey, Germany's Siemens AG is leading a corporation of companies in building a $1.45-billion, 1300-MW, coal-fired power plant near Iskenderun. The plant was scheduled for completion in 2003, and it is to burn imported coal. In addition to this large

coal-fired process, Turkey is mainly focused on increasing natural gas use for thermal electric power generation. GE Power Systems is supplying natural gas-fired turbine generators worth more than $900 million for three new united cycle power plants as the 770-MW Adapazari, 1540-MW Gebze, and 1520-MW Izmir plants [5].

However, increasing domestically generated electricity through construction of new power plants, Turkey is also looking outside its borders to help meet the country's rapidly growing power needs.

Turkey imports power from Russia, via Georgia and Iran. Russia signed an agreement with Turkey to increase its power exports to Turkey through Georgia in October 2000. Besides direct power purchases from other countries, increased natural gas imports will be used largely for electricity generation, with new LNG terminals to be attached to Independent Power Producer (IPP) gas-fired generation facilities. Turkish and Turkmen officials signed an agreement on power supplies from Turkmenistan in May 1999. In addition to these, Turkey is also importing around 3 billion kilowatt-hours (bkwh) from Bulgaria per year. In September 2000, Turkey stated its desire to increase its power imports from Bulgaria to 5 bkwh by the year 2005. Turkey has a memorandum with other Black Sea Economic Cooperation (BSEC) members to look into creation of a regional power grid.

Turkey has significant hydroelectric power resources such as the Southeast Anatolia Hydropower and Irrigation Project, which is also known as the GAP Project. It has more than 104 total plants, installed capacity over 10.2 GW, and it is developing a great deal more, especially as part of the $32-billion project. GAP is such a significant project that when completed, it will be considered to be one of the biggest water development projects ever undertaken. It will include 21 dams, 19 hydro plants around 7.5 GW of power generating capacity, and a network of tunnels and irrigation canals.

The main Turkish hydro dams are: Ataturk, 2400 MW capacity; Karakaya, 1800 MW; Ilisu, 1200 MW; Cizre, 240 MW; Silvan/Kayser, 240 MW; Hakkari, 208 MW; Alpaslan II, 200 MW; Batman, 198 MW; Konaktepe, 180 MW; and Karkamis, 180 MW [5].

The Turkish government decided to cancel a planned and often-delayed $4-billion, 1300-MW nuclear power plant in July 2000. This involved three international corporations: AECL of Canada, Westinghouse-Mitsubishi of the United States and Japan, and NPI of France and Germany. They had submitted bids to build the plant, which would have been Turkey's first nuclear plant. The project was on the southern Mediterranean coast at Akkuyu. According to given explanations, the plant was cancelled for financial reasons, although there also had been opposition from environmental and anti-nuclear groups, as well as neighboring countries [5].

3.4. Cogeneration

Cogeneration, or autoproduction, is known as Combined Heat and Power (CHP), which has been developed by governmental support to support the continuing need for additional electricity generation. There were only four cogeneration plants in operation in 1994, with a total capacity of only 30 MWe. Since then, incentives were offered by TEDAS in the form of a 100% tax deduction, duty exemptions for autoproduction facilities, and guaranteed purchasing of any surplus electricity. By mid-2001, this has been improved in Turkey so much that, there were 90 operating cogeneration plants with a total capacity of 2400 MWe, 55 cogeneration plants under construction, with an additional capacity of

2060 MWe, and 153 cogeneration plants representing another 10,400 MWe, under evaluation by the MENR. These are usually located in the so-called "Organized Industrial Zones" or "OSBs". The total installed cogeneration capacity is expected to reach up to 6000 MWe by this year (2005). That means it will represent about 20% of Turkey's total installed electricity generating capacity.

3.5. Refining/downstream

Turkey, owner of 6 refineries, having capacity of 719,275 bbl/d, at each refinery. Turkey's refining and other downstream operations are operated by partly state owned company Tupras, which has four major refining complexes. These are Batman in the southeast, Aliaga adjacent to Izmir, Izmit adjacent to Istanbul. Izmit refinery is the country's largest refinery, and the Central Anatolian Refinery at Kirikkale near Ankara. Tupras' equal parts of the Turkish fuels and lubricants bazaar was around 78%, with other main retailers comprising BP, ExxonMobil, TotalFinaElf, Agip, and ConocoPhillips in 2002 [6].

Tupras is planning to have a fifth refinery, which is a $700–$800 million establishment next to Yarimca in Northwest of Turkey and will have been built by the year 2007. Tupras is also planning a renovation program to change products at its refineries into lighter products. Turkey's only private refinery is ATAS, located near Mersin on the Mediterranean coast, which is a partnership of Mobil (51%), Shell (27%), BP Amoco (17%), and the local company, Marmara Petrol ve Rafineri Isleri AS (5%) [6].

4. Energy policy and regulation

The Turkish Parliament ratified constitutional amendments by large majorities in August 1999 that will considerably develop trade and investment. These amendments, including Law No. 4446, are planned to accelerate infrastructure projects, like power plants, by procuring easier financing and consent. One of the constitutional amendments that is a very important step is Article 47, which will provide methods and techniques for privatization [8]. This would be defined and specified by law, including which state enterprises would be privatized. Another is Article 125 of the Constitution, which was modified to give permission to settle arguments by national or international arbitration, including international arbitration to be used for arguments including a foreign entity. Article 155 of the Constitution was modified for limiting the participation of the Council of State, so-called-Danistay, in contracting. The new preparation assures Danistay the right to scrutinize cases, draft regulations, and give opinions; Danistay will also be able to settle administrative arguments; however, its powers are less than before. Bill No. 4501 was approved, carrying out these constitutional modifications into associated law in January 2000. The Turkish parliament ratified a law, which will eventually privatize most of BOTAS, the state-owned natural gas company in 2001. By the year 2009, the law would separate BOTAS into different units for gas importation, transport, storage, and distribution. To bring to a conclusion, apart from transport, all the units would be privatized. Leaving only 20% at the end, the plan is to sell off 10% of the BOTAS market share each year. In March 2001, Turkey's Electricity Market Law came to power. The law orders a free market in power generation and distribution. The state-owned Turkish Electricity Generation and Transmission Corporation (TEAS) was split into four separate

state-owned companies, these are for electricity generation (TEUAS), electricity transmission (TEIAS), electricity distribution (TEDAS), and electricity trade (TETAS), under the law [4,9].

Moreover, the new law assures a new organization, the Energy Market Regulation Agency (EMRA), which oversees the power and natural gas markets, including setting tariffs, issuing licenses, and assuring competition. On November 19, 2001, the Energy Market Regulatory Board was charged to operate the EMRA. The EMRA published drafts of the Energy Market Licensing Regulation and the Electricity Market Tariffs Regulation, and these regulations come into power in August 2002. EMRA has also declared that a 4-level step to a rivalry electricity market. The first level orders licenses to firms in the electricity and natural gas markets. The second level ensures large industrial users can choose their electricity provider and started March 3, 2003. The third level begins to regulate the Market Financial Reconciliation Center for balancing and settlements, and the fourth level makes this Center fully operational and functional. Legislation has been requested in the Turkish parliament that would extend the area of the EMRA to comprise the upstream facilities in the petroleum market. This Petroleum Market Bill is to be considered by the parliament in the near future [4].

Turkey plans a very big improvement in energy supply as its economy develops, particularly via electricity and natural gas, and has approved a policy of supporting and encouraging foreign investment in power plants and natural gas pipelines to meet the expected demand. After 1995, Turkey acknowledged new routes for energy project financing and ownership. Three models were proposed, such as "Build-Operate-Transfer" (BOT), "Build-Own- Operate" (BOO), and "Transfer of Operating Rights" (TOR).

MENR, Turkey's MENR had planned that foreign developers would construct most of the new power plants on a BOT basis. According to this model, many private investors would construct and operate power plants for several years, then eventually ownership would be transferred back to the state. The electric power generated by these projects could be sold to the national grid, the state-owned electricity authority, or even a private end user.

The TOR is a similar subject for privatization, usually set via a bidding process, a private investor or consortium receives a power plant in exchange for a transfer fee. As a next level, they operate and maintain the facility as required as long as the predetermined transfer time period. After that, the power plant is transferred back to the state without any cost or necessity. Many of Turkey's existing power plants had been expected to be privatized in this method, however the IMF is against this because of the time limits imposed on the operating rights. The IMF approves "full privatization". There are only two power plants have been privatized under the TOR so far. The BOO has been more profitably considered by power investors, as this does not impose any time limits on the project. Moreover, the economics of power generation is usually more profitable than for the BOT that results in a lower cost of power production [4].

5. Conclusions

Turkey has dynamic economic development and rapid population growth. It also has macro-economic, and especially monetary, instability. The net effect of these factors is that Turkey's energy demand has grown rapidly almost every year and is expected to continue growing. The domestic share of total energy consumption is 37%, and between the years

2000 and 2010, the cost for needed energy will be approximately 55 billion US$. The government has been planning for 81% of this amount as an investment. Considering the country's economic conditions, Turkey must come up the plan which reduces the share of fossil fuels, increases energy production (including use of more alternative energy sources), and changes the coarse of long-term energy plans into very effective and applicable solutions. In this study, energy reserves, energy demand, energy production, energy consumption, energy policies, and recent developments are investigated and evaluated.

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